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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 11336/271	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US03/20225	International filing date *(day/month/year)* 30 June 2003 (30.06.2003)	Priority date *(day/month/year)* 10 July 2002 (10.07.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): G06K, 9/00; G06T 15/00; G08G 1/123; G01C 21/26 and US Cl.: 382/154; 345/419; 340/995.17; 701/213		
Applicant HARMAN INTERNATIONAL INDUSTRIES, INCORPORATED		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 9 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 22 January 2004 (22.01.2004)	Date of completion of this report 12 November 2004 (12.11.2004)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Wenpeng Chen Telephone No. 703 306-2796

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International Application No.
PCT/US03/20225

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description:
pages 1-44 as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of ______.

☒ the claims:
pages 47, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages 45,46 and 48-54, filed with the letter of 11 August 2004 (11.08.2004)

☒ the drawings:
pages 1-19, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of ______.

☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of ______.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☒ the claims, Nos. 25-28

☐ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*
** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims	2-3, 16, 19-20, 40, 52, 59-61	YES
	Claims	1,4-15,17,18,21-24, 29-39,41-51, 53-58, 62-63	NO
Inventive Step (IS)	Claims	NONE	YES
	Claims	1-24 and 29-63	NO
Industrial Applicability (IA)	Claims	1-24, 29-63	YES
	Claims	NONE	NO

2. CITATIONS AND EXPLANATIONS

Please See Continuation Sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

The description is objected to as containing the following defect(s) under PCT Rule 66.2(a)(iii) in the form or contents thereof: In page 7, line 12, "the of direction the scanner" shall be changed to "the direction of the scanner".

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:

1. Claims 1, 4-8, 9-15, 17, 18, 21-24, 29-39, 41-51, 53-58, and 62-63 lack novelty under PCT Article 33(2) as being anticipated by Kacyra et al. (US patent 5,988,862.)

Kacyra teaches an image generation system for developing three-dimensional electronic models of objects, the image generation system comprising:

-- a scanner operable to scan an object and provide geographic position, slope, and orientation of the scanner and image data representative of the object for each of a plurality of different geographic locations of the scanner in the vicinity of the object; (column 3, lines 25-36; column 4, lines 26-41, 42-55; the FDV module 10; column 17, lines 26-37; column 27, line 60 to column 28, line 8; column 35, lines 12-21; column 5, lines 23-34; *The "origin point" is the scanner geographic position. The tilt and rotation of the scanner are the slope and orientation, respectively. The horizontal and vertical angles for steering the lidar are determined from the tilt and rotation of the scanner. The absolute coordinate of each point associated with an object is thus determined from the location of origin point and the tilt and rotation. In column 35, lines 12-21, Kacyra teaches merge two set data world together with transformation. The two sets data of the data world include images taken at each scanner location.* The color and texture of a point on an object are the image data. When two data worlds are combined, absolute positions of object points needed to be known. To get the absolute positions, the position, tilt, and rotation of the scanner for obtaining each data world shall be provided.)

-- a computing system in communication with the scanner, where the computing system is operable to generate a three-dimensional electronic model of the object by fitting together the image data provides from each of the geographic locations based on the scanner position data; (column 4, lines 11-41; column 21, lines 10-62; column 27, line 60 to column 28, line 8; column 35, lines 12-21; *In column 35, lines 12-21, Kacyra teaches merge two set data world together with transformation that is a fitting process. The two sets data of the data world include images taken at each scanner location.* When two data worlds are combined, absolute positions of object points needed to be known. The absolute positions of the objects are determined based on the position, tilt, and rotation of the scanner. Therefore, the fitting is also based on the position, tilt, and rotation of the scanner.)

-- where the scanner includes a laser scanner operable to provide geometric point data representative of a geometric shape of the object; (column 3, line 53 to column 4, line 10)

-- where the scanner includes a point scanner and a color scanner, the point scanner and the color scanner operable to synchronously provide image data representative of a geometric shape and a color of the object; (column 3, line 53 to column 4, line 10; The laser is the point scanner. The camera is the color scanner.)

-- where the scanner includes a point scanner operable to collect geometric point data representative of the geometric shape of the object, a color scanner operable to collect color point data representative of the color of the object and a positioning system operable to collect the scanner position data; (column 3, line 53 to column 4, line 10; The laser is the point scanner. The camera is the color scanner.)

-- where the computing system is operable to associate the color point data, the geometric point data, and the scanner position data to form a three-dimensional electronic image representative of only one scan of the object; (column 4, lines 11-41)

-- where the computing system is operable to selectively combine a plurality of three-dimensional electronic images as a function of the scanner position data to generate a three-dimensional electronic model; (column 20, lines 8-14; column 35, lines 11-

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

21)

-- means for scanning an object, where the means for scanning is operable to determine position data that includes geographic position, slope, and orientation of the means for scanning an object and image data representative of the object for each of a plurality of different geographic locations of the means of scanning in the vicinity of the object; (column 3, lines 25-36; column 4, lines 26-41; the FDV module 10; column 17, lines 26-37; column 27, line 60 to column 28, line 8; column 35, lines 12-21; Also see explanation above.)

-- a computing system in communication with the means for scanning, where the computing system is operable to associate the position data with corresponding image data and dynamically fit together the image data provides from each of the geographic locations based on the scanner position data to generate a three-dimensional electronic model of the object as a function of the image data and the position information; (column 4, lines 11-41; Also see explanation above.)

-- where the computing system includes means for joining a plurality of geometric points included in the image data, to form three-dimensional electronic images; (column 4, lines 11-41; column 20, lines 8-14; column 35, lines 11-21)

-- where the computing system includes means for manipulating the three-dimensional electronic images; (column 27, line 47 to column 35, line 21; Various image processing means are provided.)

-- where the computing system includes means for combining the three-dimensional electronic images to form the three-dimensional electronic model; (column 20, lines 8-14; column 35, lines 11-21)

-- where the computing system includes means for texturizing surfaces of the three-dimensional electronic model. (column 4, lines 44-55; column 21, lines 10-22)

The above passages also teach the system of Claims 9-15 and 17. For Claim 13, Kacyra further teaches the computing system includes a site computing system and a lab computing system, the site computing system is operable to perform a preliminary registration to form a preliminary three-dimensional electronic model, and the lab computing system is operable to perform precise registration of the preliminary three-dimensional electronic model to form a final three-dimensional electronic model. (Fig. 39; column 24, line 32 to column 25, line 58; The left hand side of Fig. 39 provides preliminary registration. The right hand side of Fig. 39 provides the final model.)

For Claim 17, Kacyra further teaches the three-dimensional electronic model includes a simple layer, a construction layer, a position layer and a library layer. (column 27, line 47 to column 36, line 68; Fig. 1A; Each layer is a set of stored database or software.)

For Claims 29-35, Kacyra also teaches:

-- a memory; (column 4, lines 12-18; column 37, lines 13-19)

-- instructions in the memory to perform the functions recited in the claims as discussed above; (column 16, line 54 to column 17, line 8)

-- for Claims 32-34 further

- where the instructions in the memory device to join the geometric points comprise instructions in the memory device to partition each of the three-dimensional electronic images into sub-images; (column 18, line 5 to column 19, line 35)

- where the instructions in the memory device to join the geometric points comprise instructions in the memory device to develop a plurality of lines, where each of the lines is representative of one of the sub-images; (column 18, line 5 to column 19, line 35)

- where the instructions in the memory device to combine the three-dimensional electronic images comprise instructions in the memory device to position the lines with respect to each other; (column 18, line 5 to column 19, line 35)

- where the image data also includes color points and instructions in memory to develop a plurality of lines comprises instructions in the memory device to convert the geometric points and the color points to a line that replaces the geometric points and the color points. (column 18, line 5 to column 19, line 35; column 19, lines 10-37; column 21, lines 12-61; column 22, lines 16-26; In the modeling, some points are connected to form lines.)

As discussed in the above passages, Kacyra also teaches the corresponding methods of Claims 36-39, 41-51, 53-58, and 63. Kacyra teaches that the recited color points. (column 3, lines 25-64; column 4, lines 20-55; The lidar generates range and intensity data. The video system also provides the color points.) Kacyra teaches that the source texture is an image file. (column 3, lines 25-36; column 27, line 47 to column 36, line 68; Fig. 1A; Each layer having texture information is a set of stored database and thus is associated with an identifier.)

2. Claims 2-3, 19-20, 40, and 59-61 lack an inventive step under PCT Article 33(3) as being obvious over Kacyra et al. (US patent 5,988,862) in view of Margolin (US patent 5,566,073.)

Kacyra teaches, as discussed above, image generation systems of Claims 1, 9, 18, 25, 29 and methods of Claims 36, 45, and 53. Kacyra teaches also the facing direction of the scanner. (*The horizontal and vertical angles for steering the lidar is the facing direction of the scanner.)*

However, it does not teach the features related to satellite positioning system and slope orientation sensor.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Margolin teaches synthesizing a view of world with providing navigational coordinates to be used as an electronic map comprising:

-- a satellite positioning system to provide position information that is also navigational coordinates including an elevation; (abstract,; column 6, lines 7-65; column 7, line 40 to column 8, line 3; Figs. 1 and 3)

-- an altitude sensor for providing also elevation data; (column 6, lines 7-32)

-- slope orientation sensor; (abstract,; column 6, lines 7-65; column 7, line 40 to column 8, line 3; Figs. 1 and 3)

-- where the slope orientation sensor is operable to provide a pitch, a roll and an orientation of the scanner. (abstract,; column 6, lines 7-65; column 7, line 40 to column 8, line 3; Figs. 1 and 3)

It is desirable to provide an electronic map with a 3D model drawing to facilitate understanding of objects and structures shown on the map. It would have been obvious to one of ordinary skill in the art, at the time of the invention, to use Kacyra's CAD in Margolin's system to develop an electronic map representing a synthetic environment for pilot aid because the combination generates an electronic map with a 3D model drawing to facilitate understanding of the map.

The combination thus provides navigation coordinates, an elevation, a facing direction of the scanner and a pitch and a roll of the scanner.

3. Claims 16 and 52 lack an inventive step under PCT Article 33(3) as being obvious over Kacyra et al. (US patent 5,988,862) in view of Petrov et al. (US patent Application Publication 2001/0056308.)

Kacyra teaches, as discussed above, image generation system of Claim 15 and methods of Claim 45. However, it does not teach the triangle and color blending recited in the claims.

Petrov et al. teaches generating 3D model comprising;

-- filling in color in a surface of each of the three-dimensional electronic images by division of the surface into triangles and color blending between color point data within each of the triangles. (Figs. 8(a)-(d); sections 0005, 0025, 0041, and 0047)

It is desirable to improve the appearance of a 3D model by smoothly blending an area with its neighbors. It would have been obvious to one of ordinary skill in the art, at the time of the invention, to apply Petrov's teaching to represent the surface of Kacyra's objects with triangular patches and blend the color of a patch with its neighbors because the combination improves the appearance of the 3D model.

---------------- NEW CITATIONS ----------------

Claims

What is claimed is:

1. An image generation system for developing three-dimensional electronic models of objects, the image generation system comprising:

a scanner operable to scan an object and provide scanner position data that includes a geographic position, slope and orientation of the scanner and image data representative of the object for each of a plurality of different geographic locations of the scanner in the vicinity of the object; and

a computing system in communication with the scanner, where the computing system is operable to generate a three-dimensional electronic model of the object by fitting together the image data provided from each of the geographic locations based on the scanner position data.

2. The image generation system of claim 1, where the scanner includes a satellite positioning system and a slope orientation sensor operable to provide the scanner position data.

3. The image generation system of claim 2, where the slope orientation sensor is operable to provide a pitch, a roll and an orientation of the scanner.

4. The image generation system of claim 1, where the scanner includes a laser scanner operable to provide geometric point data representative of a geometric shape of the object.

5. The image generation system of claim 1, where the scanner includes a point scanner and a color scanner, the point scanner and the color scanner operable to synchronously provide image data representative of a geometric shape and a color of the object.

6. The image generation system of claim 1, where the scanner includes a point scanner operable to collect geometric point data representative of the geometric shape of the object, a color scanner operable to collect color point data representative of the color of the object and a positioning system operable to collect the scanner position data.

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7. The image generation system of claim 6, where the computing system is operable to associate the color point data, the geometric point data, and the scanner position data to form a three-dimensional electronic image representative of only one scan of the object.

8. The image generation system of claim 7, where the computing system is operable to selectively combine a plurality of three-dimensional electronic images as a function of the scanner position data to generate a three-dimensional electronic model.

9. An image generation system for developing three-dimensional electronic models of objects, the image generation system comprising:

a point scanner operable to generate a plurality of point clouds representative of an object as a function of a plurality of respective scans of the object from a plurality of respective geographic positions around the object;

a color scanner synchronously operating with the point scanner, where the color scanner is operable to generate color point data representative of the color of the object for each of the point clouds;

a positioning system operable to provide geographic position data of the point scanner and the color scanner for each of the geographic positions; and

a computing system operable to develop a three-dimensional electronic model as a function of the point clouds, the color point data and the geographic position data.

10. The image generation system of claim 9, where the color scanner is a line sensor operable to measure a line of color in a determined area of the object, while at the same time the point scanner is operable to measure distances from a plurality of points within the same determined area.

11. The image generation system of claim 9, where the each of the point clouds includes geometric point data generated by the point scanner and the computing

17. The image generation system of claim 9, where the three-dimensional electronic model includes a simple layer, a construction layer, a position layer and a library layer.

18. An image generation system for developing three-dimensional electronic models of objects, the image generation system comprising:

means for scanning an object, where the means for scanning is operable to determine position data that includes a geographic position, slope and orientation of the means for scanning an object and image data representative of the object for each of a plurality of different geographic locations of the means for scanning in the vicinity of the object; and

a computing system in communication with the means for scanning, where the computing system is operable to associate the position data with corresponding image data and dynamically fit together the image data from each of the different geographic locations based on the position data to generate a three-dimensional electronic model of the object.

19. The image generation system of claim 18, where the means for scanning includes means for determining navigational coordinates and means for determining slope, orientation and height of the means for scanning.

20. The image generation system of claim 19, where the computing system includes means for geometrically assembling the three-dimensional electronic model as a function of the navigational coordinates, the slope, orientation and height.

21. The image generation system of claim 18, where the computing system includes means for joining a plurality of geometric points included in the image data, to form three-dimensional electronic images.

22. The image generation system of claim 21, where the computing system includes means for manipulating the three-dimensional electronic images.

23. The image generation system of claim 21, where the computing system includes means for combining the three-dimensional electronic images to form the three-dimensional electronic model.

24. The image generation system of claim 18, where the computing system includes means for texturizing surfaces of the three-dimensional electronic model.

29. An image generation system for developing three-dimensional electronic models of objects, the image generation system comprising:

a memory device;

instructions in the memory device to store a plurality of three-dimensional electronic images, where each of the three-dimensional electronic images includes image data captured during a scan of an object

instructions stored in the memory device to associate position data indicative of a geographic location and orientation of a scanner used to capture the image data with the image data captured from the perspective of that geographic location;

instructions in the memory device to join a plurality of geometric points

included in the image data of each of the three-dimensional electronic images; and

instructions in the memory device to combine the three-dimensional electronic images to form a three-dimensional electronic model as a function of the position data.

30. The image generation system of claim 29, further comprising instructions in the memory device to texturize the three-dimensional electronic model.

31. The image generation system of claim 29, where the instructions in the memory device to join geometric points comprise instructions in the memory device to form surfaces within each of the three-dimensional electronic images.

32. The image generation system of claim 29, where the instructions in the memory device to join the geometric points comprise instructions in the memory device to partition each of the three-dimensional electronic images into sub-images.

33. The image generation system of claim 32, where the instructions in the memory device to join the geometric points comprise instructions in the memory device to develop a plurality of lines, where each of the lines is representative of one of the sub-images.

34. The image generation system of claim 33, where the instructions in the memory device to combine the three-dimensional electronic images comprise instructions in the memory device to position the lines with respect to each other.

35. The image generation system of claim 29, where the instructions in the memory device to combine the three-dimensional electronic images comprise instructions in the memory device to positionally manipulate the three-dimensional electronic images with respect to each other.

36. A method of developing a three-dimensional electronic model representative of an object, the method comprising:

performing a scan of an object in each of a plurality of geographic positions with a scanner;

collecting image data and corresponding geographic position data of the scanner during each scan with a computer;

the computer developing a three-dimensional electronic image representative of each scan from the image data collected during the scan; and

the computer combining a plurality of three-dimensional electronic images as a function of the geographic position data that is associated with each of the three-dimensional electronic images to form a three-dimensional electronic model representative of the object.

37. The method of claim 36, where performing a scan comprises determining geometric points representative of the geometric shape of the object.

38. The method of claim 36, where performing a scan comprises determining color point data in a line of color within an area while determining geometric point data within the same area.

39. The method of claim 36, where collecting image data and position data comprises synchronously collecting geometric point data and color point data representative of the object.

40. The method of claim 36, where collecting image data and position data comprises determining navigational coordinates, a facing direction, a pitch, a roll and a height of a scanner used to perform the scan.

41. The method of claim 36, where combining a plurality of three-dimensional electronic images comprises associating the image data with the position data.

42. The method of claim 36, where combining a plurality of three-dimensional electronic images comprises manipulating at least a portion of the three-dimensional electronic images with respect to each other.

43. The method of claim 36, further comprising selecting a source texture as a function of a texture of the object; developing a transformation procedure to create a

complex texture from the source texture; and associating the transformation procedure with a surface of the three-dimensional electronic model.

44. The method of claim 36, where the object includes a symmetrical portion and developing a three-dimensional electronic image comprises mirroring the image data from a scanned portion of the object to the symmetrical portion of the object.

45. A method of developing a three-dimensional electronic model representative of an object, the method comprising:

scanning an object with a scanner from a plurality of positions to develop a respective plurality of three-dimensional electronic images, where each of the three-dimensional electronic images is represented with a plurality of geometric points in a point cloud and a plurality of color points;

portioning one of the three-dimensional electronic images into a plurality of sub-images;

converting the geometric points and the color points into a plurality of lines representative of the respective sub-images; and

combining the lines to develop a three-dimensional electronic model.

46. The method of claim 45, where converting the geometric points and the color points comprises storing the lines representative of the sub-images as an outline data file.

47. The method of claim 45, where scanning an object comprises scanning from a plurality of positions to generate a plurality of respective point clouds.

48. The method of claim 45, where combining the lines comprises manipulating the lines with respect to each other to precisely fit together.

49. The method of claim 45, where combining the lines comprises minimizing error in the distance between one of the lines and another of the lines.

50. The method of claim 45, further comprising compensating for height when the resting surface that the object rests upon is sloped.

51. The method of claim 45, further comprising filling gaps in color in the three-dimensional electronic model by rasterization.

52. The method of claim 45, further comprising dividing a surface of each of the three-dimensional electronic images into triangles and color blending within each of the triangles to fill gaps in color.

53. A method of developing a three-dimensional electronic model representative of an object, the method comprising:

capturing a plurality of scans of an object, where each of the scans includes image data representative of a three-dimensional electronic image and position data indicative of the position from which each scan was captured;

combining the scans to form a three-dimensional electronic model of the object as a function of the position data; and

texturizing the three-dimensional electronic model as a function of a source texture that is an image file identified with a unique identifier and stored in a source texture library.

54. The method of claim 53, where texturizing comprises associating a texture with a surface of the three-dimensional electronic model.

55. The method of claim 53, where texturizing comprises selecting a source texture, creating a transformation procedure to transform the source texture to form a complex texture, and associating the transformation procedure with a surface of the three-dimensional electronic model.

56. The method of claim 53, further comprising organizing the three-dimensional electronic model into a structure that includes a plurality of layers.

57. The method of claim 53, where texturizing comprises searching the source texture library that includes a plurality of source textures, transforming a source texture to form a complex texture for a surface of the three-dimensional electronic model and storing in the library a transformation procedure to form the complex texture.

58. The method of claim 53, further comprising storing the three-dimensional electronic model as a datafile.

59. The method of claim 58, further comprising accessing the datafile to display the three-dimensional electronic model in an electronic map.

60. The image generation system of claim 1, where the scanner position data includes navigational coordinates, an elevation, a facing direction of the scanner and a pitch and a roll of the scanner.

61. The image generation system of claim 9, where the position system includes a satellite positioning system, a sensor configured to sense a facing direction and a sensor configured to sense a pitch and a roll of the sensor.

62. The image generation system of claim 33, where the image data also includes color points and instructions in the memory device to develop a plurality of lines comprises instructions in the memory device to convert the geometric points and the color points to a line that replaces the geometric points and the color points.

63. The method of claim 45, where converting the geometric points and the color points comprises replacing the geometric points and the color points with the lines that are representative of the geometric points and color points.